FARMERS' BULLETIN NO.1897 • U.S. DEPARTMENT OF AGRICULTURE

Establishing and Managing YOUNG APPLE ORCHARDS

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Agricultural Research Service

Washington, D.C. Revised February 1967

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Washington, D.C. 20402 - Price 15 cents

ESTABLISHING AND MANAGING YOUNG APPLE ORCHARDS

IMPORTANCE OF YOUNG ORCHARDS

Approximately 29 million apple trees were grown on farms in the United States in 1960. About 9 million of these trees were of nonbearing age. About half were in orchards of 500 or more trees or of sufficient size to represent commercial production. From these trees, crops of 110 to 120 million bushels commercial production have been harvested most years from 1954 to 1960. In addition, considerable quantities of fruit from noncommercial orchards were consumed locally.

The average life of a commercial orchard for the United States as a whole appears to be not over 40 years. In northern sections, such as New England, New York, and Michigan, where trees develop more slowly, some orchards may last 50 years or more. In sections where the tree develops more rapidly, orchards of 35 to 40 years have frequently passed the time for the most economical production of good-quality fruit. Thus, it would appear that most commercial orchards should be replaced at least by the time they are 40 years of age.

Fruit of the best size and quality is invariably produced on relatively young trees. Because of the height of large old trees, it is difficult to spray them thoroughly and expensive to prune them and to thin and pick the fruit. The various regions that have attained reputations for producing high-quality apples made these reputations when the orchards were relatively young. Renewal of the orchard permits the planting of the best varieties and strains. Practically every orchard as much as 35 years old contains a number of varieties that would not be planted today, because they have proved to be inferior as commercial varieties. Also, such orchards do not contain the newer varieties that have proved to be outstanding in recent years.

For these reasons, the apple orchard must be systematically renewed if good-quality fruit is to be produced. Instead of maintaining orchards to as old an age as possible, new acreage should be systematically planted to replace the old, or old orchard sites should be replanted. If orchards are re-

placed at not more than 35 to 40 years of age, trees can be planted somewhat closer together and production per acre increased during the principal producing life of the trees.

About 6 to 8 years are usually required before appreciable production is obtained on apple trees in most parts of the United States and from 8 to 10 years, before the orchard produces much tonnage. About one-fourth of the life of the trees is required to bring them into good production. A grower who is systematically renewing his orchard will need to have approximately one-fourth of his acreage under 10 years of age in order to bring about such systematic renewal. In the United States, about 12 million trees in this nonbearing or a very early bearing stage would be required to maintain 40 million trees of bearing age in orchards. This bulletin deals with the selection of orchard sites, planning and planting the orchard, and care of this nonbearing orchard acreage.

SELECTION OF SITES

Frost Injury

Too much emphasis cannot be placed on the importance of air drainage from the standpoint of apple production. In most parts of the United States, spring frosts or freezes shortly before, during or after bloom constitute a tremendous hazard to apple production. This hazard can be reduced by selecting the most favorable sites for orchard planting, although in most parts of the United States it cannot be entirely eliminated.

Cold air, which is heavier than warm air, tends to settle into low spots. On still, frosty nights the temperature in valleys or depressions surrounded on all sides by higher land may be several degrees colder than that in more elevated locations. Under such conditions, a difference of 100 feet in elevation may make a difference of 2° to 10° F. in the minimum temperature encountered. In many seasons, such differences would mean the difference between a full crop and a crop failure. The first prerequisite of a site for the apple orchard is that it be sufficiently elevated so that the cold air can settle below the orchard during the cold nights of spring.

Sites above good-sized streams or lakes, that have free opportunity for the cold air to settle from the orchard to the water, are particularly favorable from the standpoint of frost protection. Timber surrounding the lower side of an orchard may tend to collect the cold air into a frost pocket, even though the slope of the land is away from the orchard.

Although it is desirable that the orchard be located on a site sufficiently elevated to secure good air drainage, sites on the tops of ridges may be unsatisfactory from several standpoints. Such sites are exposed to heavy winds, which do much injury to trees and fruits. Wind may also interfere with spraying operations. Exposure to very cold winds in winter may increase the hazard of low winter temperatures. The slopes along the sides of ridges are generally more desirable than the tops.

The location of the orchard on a very steep slope offers a number of problems in the later management

of the orchard. On such steep hillsides spraying often becomes a serious problem. Cultivation of steep hillsides may also be impracticable because of the danger of erosion but fortunately the apple thrives well under permanent or semipermanent sod systems. Consequently, if the soil is satisfactory, apple orchards can be planted on steeper slopes than would be satisfactory for other fruits that need cultivation.

Many orchard operations, such as pruning and thinning, harvesting, and hauling of the fruit, are more difficult on steep hillsides than on more level land. However, the excellent air drainage usually found on such sites may more than compensate for problems in management. Many successful apple orchards are located on slopes of as much as 20°. Figure 1 shows such a location, where most of the orchard has excellent air drainage.

Soil

A second consideration equally important in determining where the orchard should be located, is the soil. Establishing and maintaining an orchard to bearing age is expensive, costing in most parts of the United States from $1,000 to $2,000 per acre. Many orchards have been planted on soils so shallow or so poor that an intelligent examination of the soil would have shown at the start that there was little chance for success. The old idea that soil unfit for other use is satisfactory for an orchard has been costly to many growers. Soils may be too steep or too stony for general farm crops and still be well adapted to orchards. However, the heavy investment necessary for establishing an orchard should not be made on a soil that is not certain to be satisfactory for the purpose.

The most important factors to consider in the soil are—

- Drainage and aeration. Apple orchards usually are not successful on soils that become waterlogged and remain in that condition for any appreciable length of time.
- Waterholding capacity. This includes a consideration of both the texture of the soil and its depth.

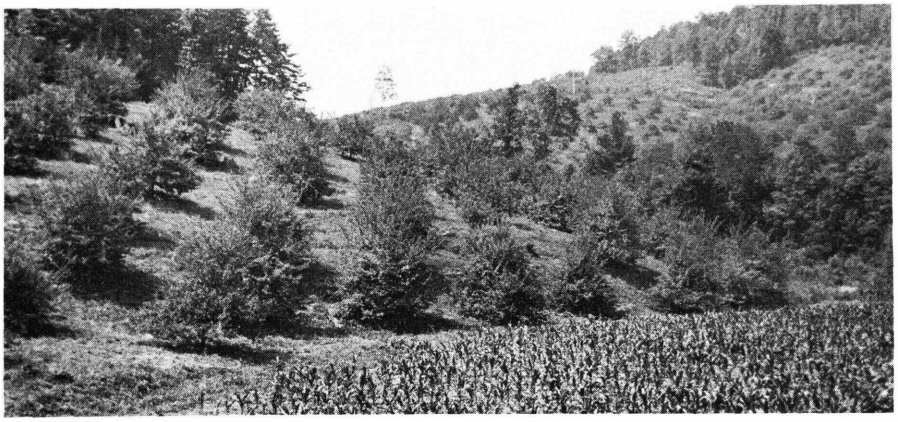

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Figure 1.—Apple orchard on a rather steep hillside. Frost rarely reduces the crop on the trees in the upper two-thirds of the orchard, but frequently it reduces or destroys the crop on the lower trees.

- Capacity to absorb water readily from rain or irrigation.
- Fertility.

Soil Drainage and Aeration

In many soils, the subsoil is so heavy and impervious to water movement that water does not drain out of the ground freely. In such soils, the spaces between the soil particles become filled with water during wet seasons. This water excludes the oxygen of the air, which is essential for root growth and, in fact, for maintenance of life in apple roots.

If the soil has been drained for a period of time and root development has occurred, a period of waterlogging of any considerable duration while the trees are in active growth will result in the death of the roots. The roots can stand some submergence during the dormant period, provided the water drains away by the time growth starts in the spring. Submergence of the root system for even a few days during the summer growing season, when temperatures are high, usually results in the death of the roots.

Consequently, in soils that tend to be waterlogged, the root system of apple trees is usually confined to the relatively shallow surface layers of soil. Although the tendency to become waterlogged is greater in the heavier types of soils, even soils that are sandy and porous on the surface may have a tight subsoil that prevents the drainage of excess water. Poor drainage can frequently be detected by an examination of the subsoil. Poorly drained subsoils in many cases are mottled in color, and have prominent gray streaks and rusty brown spots, which indicate a lack of adequate aeration.

Unless it is clear that the soil is well drained, test holes can be dug to determine whether standing water is present and, if so, how long it stands in the holes in the spring. If water stands within 3 to 4 feet of the surface in such test holes for several weeks after growth starts in the spring, the site is undesirable for orchard purposes.

Even in soils free of standing water, root development is usually sparse and slow in fine-textured soils with limited airspace. Both root growth and top growth of trees are more rapid in open-textured than in fine-textured soils, provided moisture is ample. The ideal fruit soil is one having a moderately open texture, but sufficiently deep and well drained to permit deep rooting. Although available waterholding capacity per foot of depth (see p. 5) is less in moderate than in fine-textured soil, this lack is compensated for if the moderate-textured soil is of somewhat greater depth. Thus, moderate-textured soils of good depth and drainage are ideal for apple production.

Waterholding Capacity

Any soil will hold a certain amount of water against the force of gravity, which causes the free water in the soil to move downward. The amount of water the soil will hold against gravity is known as the field capacity. It cannot be changed appreciably by any cultural operation. The building up of organic matter in the soil will tend slightly to increase its capacity to hold water, but this is generally limited to a few inches on the surface. Organic matter in the soil is more important from the standpoint of improving water penetration than from that of actually increas-

ing the waterholding capacity of the soil.

In general, the finer textured the soil, the greater the amount of water it will hold per foot of depth. An open, sandy soil will usually hold water not in excess of 10 percent of the weight of the soil. A finer, silt-loam soil may hold 20 to 25 percent of its weight in water. Heavy clay soils may hold as much as 30 to 35 percent of their weight in water, although such fine soils are likely to be poorly drained, and this is not satisfactory for tree growth, as discussed on page 4.

Not all the water that a soil will hold is available for plant growth. A certain residue cannot be extracted from the soil by plants. In most soils, about half or a little more of the total water the soil will hold is available for plant growth. The amount of water in the soil at the time plants can no longer extract sufficient water to prevent their wilting is known as the wilting percentage of the soil. The amount of water between the field capacity and the wilting percentage is referred to as available water, or the amount of water available for plant growth.

A sandy soil that has a field capacity of 8 percent is likely to have a wilting percentage of 2 to 4 percent, and the available water would equal only 4 to 6 percent of the weight of the soil. In a layer of soil a foot deep, 6 percent of moisture corresponds to a layer of water approximately 1 inch deep over the soil surface, or the amount that would fall in 1 inch of rain. Such a sandy soil 4 feet deep would store up, available for the trees, only 3 to 4 acre-inches of water.

In contrast, a good silt-loam soil with a field capacity of 20 percent and a wilting percentage of 8 would store 2 inches of available water for each foot of depth. For this reason, the sandier types of soils are suitable for apple-orchard planting only when deep and well drained. Approximately twice the depth of soil is necessary in a medium sandy soil and would be necessary in a silt-loam soil to carry the trees through the same period of drought or the same interval between irrigations.

During the summer months, mature apple orchards will use about 4 to 6 acre-inches of water per month, the amount depending on the cover crop and the rate of evaporation. If the soil will hold 8 acre-inches within the root zone of the trees, rainless periods of 4 to 6 weeks will not be very serious. In non-irrigated orchards, such a soil will provide adequate insurance against serious drought hazard in those parts of the country where total annual rainfall exceeds 35 inches. In soils holding less than about 8 inches of available water within the root zone, drought hazard is high, particularly in the warmer parts of the country. Even under irrigation, soils of such waterholding capacity are highly desirable, as the intervals between irrigations can be longer than on soils of limited waterholding capacity.

Water Penetration

Good orchard soils take up water readily. This is equally important whether the orchard is to be maintained under irrigation or under natural rainfall. In soils that take up water very slowly, the runoff is likely to be heavy during periods of rain. This not only results in erosion, but, what is equally serious,

the water is lost to the orchard. The problem caused by the nonpenetration of water into heavy impervious soils makes irrigation difficult in many orchards. Therefore, a soil sufficiently open to absorb rainfall or irrigation water is highly desirable. The maintenance of adequate organic matter in the surface soil greatly increases water penetration.

Fertility

In general, the characteristics of the soil in regard to waterholding capacity, water penetration, and aeration are more important from the orchard standpoint than is the question of fertility. Most soils in the United States are well supplied with the mineral elements necessary for tree growth, except for nitrogen. Nitrogen can be added in the form of commercial fertilizers. Other elements occasionally lacking in orchard soils, such as potassium, boron, and zinc, can also be supplied. The actual fertility of the soil is relatively less important than its physical characteristics.

PLANNING AND PLANTING

Planning

The planting plan for the orchard should be based on the site and on the management practices to be followed. Where ample moisture is usually available, from either irrigation or natural rainfall, and where soils are of good depth and texture for apple production, apple trees can be grown satisfactorily with the areas between the trees in permanent or semipermanent sods. In growing areas, the ground immediately around the trees should be cultivated or mulched while the trees are young. Where the orchard can be maintained in sod, the problem of erosion control is largely eliminated. Where such sods are maintained, orchards even on relatively steep slopes are not seriously affected by erosion, and special planting plans for erosion control are not necessary.

In sections of the country where the annual rainfall is less than 35 inches per year and where irrigation is not feasible, it is essential that all of the water that falls be absorbed by the soil, not only to prevent erosion but also to provide sufficient water for the trees. Under such conditions it may be desirable to practice partial cultivation with cover crops in order to reduce the competition between the trees and the cover crops for the limited water that is available. If cultivation is to be practiced in the orchard, particularly through much of the growing season, the trees should be planted so that erosion will be reduced to the minimum. This means planting the trees on the contour or with all those in a row at the same level in the orchard, either with or without the construction of definite terraces at the point of tree planting.

Where conditions appear satisfactory for maintenance of good sod covers in the orchard, the square or the rectangular system of planting is usually desired. In the square system, trees are planted at equal distances from one another in rows running in two directions. In the rectangular system the trees are planted somewhat closer together in one direction than in the other. For example, the trees might be

planted 20 feet apart in the row, with rows 30 feet apart. The latter system provides greater space between the rows in one direction, which facilitates moving through the orchard for spraying, hauling fruit, and other operations, particularly after the trees have attained large size.

Where erosion may be a problem and where the orchard is to be maintained under cultivation, the planting of the trees on the contour on sloping ground has many advantages. Planted on the contour, all trees in a row are in soil at the same elevation. The rows are not straight, but run around the slopes of the hills in such a way as to maintain an approximate level for the trees in any row. Under such planting conditions, cultivating should be done entirely between the rows planted on the contour, and not up and down hill. Cultivation under these conditions tends to build slight ridges at the tree row, which increase absorption by reducing the tendency of the water to run down the slope. Natural, rather low terraces eventually result from such contour planting coupled with contour cultivation.

Obviously the tree rows are not equally spaced in all parts of the orchard. On the steeper slopes the rows would tend to be closer together, while they would be farther apart on the less steep areas. An orchard laid out by the contour system is shown in figure 2. On steeper parts of the orchard, it may be necessary to drop out parts of rows in order to prevent their coming too close together.

The third method of planting involves the construction of actual terraces prior to the planting of the trees. The site is terraced as for other farm operations, by throwing up ridges along the contour high enough to collect the water from

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Figure 2.—An orchard planted on the contour, showing cultivation that results in building low terraces in the tree rows. (Courtesy of the Soil Conservation Service.)

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above. The trees are planted on the ridge of soil forming the terrace. On gentle slopes it may not be necessary to build a terrace for each tree row. In that case, the intermediate tree rows not on terraces are on the contour, and natural terraces tend to develop, as indicated above. Since the terraces are built mainly of topsoil, growing conditions on such terraces are usually very favorable for the young trees. But these terraces are difficult to cross with equipment in spraying, hauling fruit, etc. Figure 3 shows an orchard with a few terraces and with the remaining tree rows on the contour.

Spacing the Trees

The proper distance for setting the trees will vary with the variety, with the fertility and waterholding capacity of the soil, and with the plan to thin the stand of trees as they attain large size. It is not possible to grow good-quality apples where the fruit is almost permanently shaded. The trees must be sufficiently far apart to allow the sun to hit the lower branches, if fruit of satisfactory quality is to be grown on the lower parts of the trees.

The age at which trees planted a given distance apart will begin to crowd will vary with the fertility of the soil and the inherent vigor of the tree. Such vigorous varieties as McIntosh and York Imperial, planted 20 feet apart in fertile soil, may crowd when only about 12 years of age; planted 25 feet apart they will usually crowd when about 20 years of age. Less vigorous trees such as Rome Beauty, Winesap, and Golden Delicious, planted 20 feet apart, would not crowd seriously until 16 to 18 years of age.

If trees are planted on the square 20 feet apart, diagonal rows can be removed later, leaving the trees approximately 28 feet apart. Trees planted 25 feet apart on the square

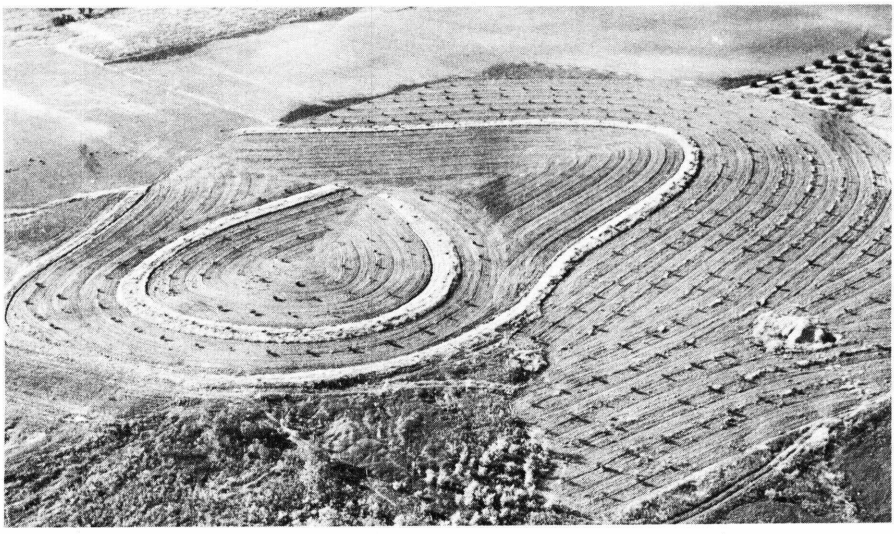

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Figure 3.—Aerial view of an orchard with a few terraces constructed prior to planting trees. The rest of the tree rows are on the contour. (Courtesy of the Soil Conservation Service.)

would be 35 feet apart after the removal of the diagonal rows. On most soils, a permanent distance of 25 to 27 feet should be most satisfactory for moderately vigorous varieties, and 30 to 35 feet for the most vigorous varieties on standard rootstocks. If dwarfing rootstocks or spur-type trees are used, the trees may grow to be only one-third to one-half the size of the normal tree and the planting distances should be correspondingly reduced.

Many growers prefer an unequal spacing of the trees, with wider distance between the trees in one direction than in the other. For vigorous varieties, they prefer to have the trees about 18 to 25 feet apart in rows in one direction and 25 to 35 feet in the other, rather than having them on the square.

Such an arrangement is advantageous because in the young orchard, wide centers are available in one direction for intercropping, and in the mature orchard greater space is available for spraying, hauling fruit, and other operations. Where such a system is used on sloping ground, it is preferable to have the more closely planted rows go across the slope rather than up and down, as cultivation, hauling, and spraying up and down the slope may start erosion. Such a system does not lend itself to close planting while the trees are young as readily as does planting on the square, but where orchards are initially set at what is planned to be the permanent distance, the plan has much to recommend it.

The desirability of closer planting while the orchard is young, with later removal of half the trees, depends largely upon how the land can be utilized for intercrops. If it is possible to produce crops that will return a revenue during the early years of the orchard, it may be better economy to plant the trees at the permanent spacing. However, if the soil is steep or broken or if for other reasons crops between the trees cannot be produced profitably, the orchard may well be more closely spaced and half the trees may be removed when crowding occurs. The great danger in such a program is that the interplants will be allowed to remain too long in the orchard causing serious injury to the permanent trees from crowding before thinning.

Arrangement of Varieties

In most instances, apple varieties are not sufficiently self-pollinating to be dependably productive if planted alone. Some varieties will produce partial crops under these conditions, but for the most dependable and uniform crop production, provision for cross-pollination must be made. Orchard observations and experimental results indicate that, to obtain the most dependable set of fruit, trees should not be farther than two tree rows from pollinizer varieties.

On the other hand, it is generally preferable to have all of the trees in one row of the same variety. This facilitates harvesting operations, and if special spray programs are desirable for particular varieties they can be applied better if varieties are planted in solid rows.

Where varieties selected are all good pollinizers, from the standpoint of fruit set, two varieties are sufficient for planting. If one variety is a poor pollinizer, as is the case with such varieties as Winesap, Stayman Winesap, Rhode Island Greening, and others, it is desirable to have more than two varieties in-

terplanted in order to obtain an adequate set.

Where it is desirable to plant the bulk of the orchard to one variety, this can be accomplished by planting four rows of the major variety followed by one row of a pollinizing variety and then an additional four rows of the major variety. If the major variety itself is a poor pollinizer, it will be preferable to plant four rows of the major variety, followed by one row each of two pollinizing varieties. If the grower wants to keep the number of trees of pollinizing varieties to the minimum, the two pollinizing varieties can be alternated in one row, although this is not normally the best arrangement. Experience indicates that where the blocks of trees of a variety are more than four rows wide, trees in the interior rows tend to set fruit more sparingly than the trees next to the pollinizing varieties.

Selection of Nursery Stock

In the United States, apple trees are generally propagated on seedling apple roots and grown for a year in special nurseries. When these seedlings are 1 year old they are dug while dormant and sold to the fruit nurserymen, who plant them out a few inches apart in rows for later budding or use them for piece-root grafts.

When propagated by budding, these seedlings are budded to the desired varieties in August or September following their planting in commercial nurseries, or approximately 18 months after the seed was planted. The following spring the young trees are cut back to the variety bud before growth starts. This bud normally makes strong growth in the nursery row. At the end of 1 year, these trees may be sold as 1-year nursery trees.

Where the growth is not sufficient to form large trees in one season, as is frequently the case in northern nurseries, these 1-year trees are headed back and grown a second season in the nursery row; they are referred to as 2-year trees. The 2-year trees are normally larger and have heavier trunks than 1-year trees, and the tops are considerably branched. So-called 1-year budded trees represent 1-year-old variety tops on 3-year-old seedling roots, and the 2-year budded trees represent 2-year-old tops on 4-year-old roots.

Either the 1-year or the 2-year trees are very satisfactory for orchard planting. Only No. 1 nursery trees of either age should be planted, as the No. 2 or smaller sized trees may be smaller because of inherently less vigorous roots. Where only trees that have made a uniformly good growth in the nursery are planted in the orchard, uniform results can be obtained, even though there is variability in the rootstocks on which the trees are grown. Apparently the trees on less vigorous roots are largely eliminated in the nursery row if only uniformly well-grown trees are planted.

Piece-root grafting is used instead of budding in apple propagation to some extent in the Middle Western States and to a limited extent elsewhere. With this method, short sections of roots, usually 1 year old, are dormant grafted to long scions and lined out in the nursery with only one or two buds above ground. Usually such trees are 2 years from grafting when offered for sale.

Cold-resistant varieties, when piece-root grafted, have their seed-

ling roots, which may be relatively tender, deeper in the ground and better protected from cold than when budded. Often roots form from the scion, which is an advantage if the scion is cold resistant. Hardy scions may be worked on such piece roots, planted in the orchard, and later top worked, preferably in the main branches, to more tender but better quality varieties.

Hibernal crab, in the colder parts of the Middle West, has given outstanding results with such intermediate trunk and crotch varieties. Other hardy varieties for frame working are Robusta No. 5, Antonovka, Charlamoff, Duchess, Beacon, Yellow Transparent, Hawkeye Greening, and McIntosh.

Where such intermediate hardy varieties are used or where the permanent scion variety itself is especially cold resistant, piece-root grafts appear preferable to budded stock. For sections where special resistance to low temperatures is not required, however, budded stock appears fully as satisfactory as root-grafted stock for general orchard use.

Special rootstocks and intergrafted stems are now used to dwarf scion trees to known and reliably predictable small sizes. Some are known to dwarf trees to one-fourth the size normal for the variety.[1]

Time of Planting

In the milder parts of the United States where minimum temperatures are not likely to go below 0° F., apple trees may be planted at any time the ground is not frozen during the late fall, winter, or early spring. In the colder sections, late-fall or early-winter planting may result in winter injury.

The roots of apple trees are more tender to cold than other portions. Exposed apple roots may be killed by temperatures of 20° to 24° F. If nursery trees are being handled in winter, it is necessary to use great care to prevent cold injury to the roots.

New root development will occur when the soil temperature is above 45° F. Spring planting, therefore, should be completed as soon as possible after frost is out of the ground, in order to allow some root development by the time top growth starts. If planting is done in the very early spring, trees will grow about as well as after fall or winter planting. In general, the later in the spring the trees are planted the poorer the growth response will be, because of the poor establishment of the new root system when top growth begins.

Method of Planting

It is desirable to dig a hole somewhat deeper and larger than necessary to take in the root system of the tree. Any broken or injured roots should be trimmed off, but the root system should not be reduced more than necessary prior to planting. The roots of nursery trees contain much stored nitrogen and other plant foods, which are used in forming both new root growth and new top growth.

The trees should usually be set at approximately the same depth as they were grown in the nursery. Planting the trees too deep should be avoided, particiularly in heavy or rather poorly drained soil. In

[1] For information on dwarf fruit trees, ask your county agricultural agent or write to the U.S. Department of Agriculture, Washington, D.C. 20250. Send your request to the Department on a post card and include your ZIP Code.

dry areas, however, it may be desirable to set the trees somewhat deeper than they were in the nursery in order to have the roots in contact with moist soil.

Where distinct soil layers occur and the surface soil is more fertile than the subsoil, it is desirable that surface soil be filled in around the roots. In heavy soils, better root development and better growth have been obtained when well-soaked peat moss was mixed with the soil surrounding the roots. The fact that such benefit has usually not occurred in lighter soils indicates that the beneficial effect is generally due to aeration. It is known that good aeration is essential for the best development of apple-tree roots. If peat is used, it should be soaked in water, as dry peat will take up water slowly from the soil.

The soil should be packed firmly around the roots in order to establish good contact. If the planting has been done a month or 6 weeks before top growth would normally begin, the young roots should have pushed into the soil before much top growth starts. In most sections, there will be ample moisture in the soil at the time the planting is done; but, should the soil be dry, the soil surrounding the roots should be soaked after planting.

SOIL MANAGEMENT

Although mature apple trees will thrive well in permanent grass or other sod culture, young trees should be protected from competition with other vegetation until they are well established. The roots of young apple trees are not deeper in the soil than the roots of grass or weeds, and if such plants are permitted to grow near the trees they will compete with them for water and nutrients and greatly reduce their growth rate.

It is essential that the soil be so managed as to prevent the competition of other vegetation near the trees during the first few years they are in the orchard. This is most commonly accomplished by cultivation, either with or without the use of intercrops between the tree rows. In many sections of the country, herbicides are being used successfully to control competing vegetation around young trees.

Cultivation, Cover Crops, and Intercrops

Probably the most widely used method of handling apple orchards during the first few years is cultivation of the whole area between the trees, with seeding of cover crops in midsummer to late summer. These cover crops should be allowed to grow until the growth on the trees is well started in the spring. They are then disked into the soil and the orchard cultivated just enough to prevent excessive weed growth during late spring and early summer. In July or early August a new cover crop is planted. None of the organic material grown in the orchard is removed, and there is no income from the land until the trees begin to bear. The cover crop should be fertilized if necessary to promote good growth.

Such a system of handling is very satisfactory from the standpoint of

tree growth. Where trees are interplanted with so-called filler trees, which make a minimum distance between the trees while the orchard is young, the system of using cover crops is generally more satisfactory than attempting to grow intercrops between the tree rows, since the area that could be devoted to intercrops between each two tree rows would be relatively narrow.

In most parts of the United States, rye is particularly satisfactory as a winter cover crop. It is so hardy that it is rarely winterkilled, and it forms a heavy top growth and a surface mat of roots, which is very effective in reducing erosion. Where winters are not too severe, a mixture of vetch and rye is very satisfactory. A good system for young apple orchards is to disk next to the trees by the time the rye heads, and to allow the rye in the centers away from the trees to ripen before disking, as the riper rye is much more valuable for increasing the organic-matter content than that disked in while still green and succulent. Seeding should be done early enough in the summer to insure a dense cover on the soil before cold weather stops growth.

Where a heavy cover crop is incorporated into the soil each spring, the loosening of the soil and the additional organic matter that result tend to reduce greatly the amount of erosion. On moderately steep slopes, however, and particularly in areas where heavy summer rains may occur, cultivation during the early summer may result in too much washing to be satisfactory, even though heavy cover crops have been disked in. Under such conditions permanent sods with strip cultivation along the tree rows, or mulching around the trees, as discussed subsequently (p. 14), is more satisfactory.

Frequently a young orchard, if on a fairly level site and in good soil, can be interplanted for a few years with cultivated crops, such as potatoes, peas, beans, cabbage, and strawberries. Where such crops are used, it is desirable not to have the rows nearer than 5 to 6 feet from the tree rows during the first 2 years, with increasing distance as the trees become older. The areas between the tree rows and cultivated crops should be kept cultivated during the spring and early summer. If the site and soil are such that erosion does not occur, tree growth under such conditions is usually very satisfactory. This is particularly true if cover crops and fertilizers are used to maintain the fertility of the soil.

In some parts of the country, alfalfa, clover, or grass may be grown to excellent advantage between the young trees. With these crops also, in order to maintain growth, it is desirable that strips adjacent to the trees be kept cultivated or that other provision be made to prevent competition close to the tree (fig. 4). With such sod crops, the cultivated strip on each side of the tree rows should be at least 5 to 6 feet wide during the first 2 years and should be gradually widened as the trees become larger. Such strip cultivation should be continued until the trees reach bearing age; after that, shading is usually sufficient to prevent heavy growth of the sod crop near the tree trunks.

Occasionally, tree hoppers may injure young trees when alfalfa or clover is grown in the orchard. These crops are favorite hosts for tree hoppers and large populations

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Figure 4.—Wide cultivated strips adjacent to tree rows in young apple orchard. Center strips, alfalfa.

may build up in them. The hoppers then may severely puncture young branches of fruit trees in egg laying. Such damage rarely occurs if alfalfa and clover are kept well away from young trees.

Mulching

An alternative to cultivation along the tree rows in young orchards is mulching around the trees with straw or other vegetable matter. To be effective, such mulches must be heavy enough to prevent the growth of weeds or other vegetation around the tree. They should cover an area extending at least 3 to 4 feet out from the trunk during the first 2 years and continuing out to beyond the spread of the branches as the trees increase in size. Such mulches should be 6 to 8 inches thick when applied and should be renewed often enough to keep down competing vegetation.

The use of an organic mulch having a relatively high nitrogen content not only will do everything a cover crop will do, but will do it better because this type mulch tends to release essential nutrients in the proper balance for ideal tree growth and production.

In orchards maintained in grass or legume sods, ample mulching material often can be obtained by mowing, raking up the mowed material, and piling it around the trees. On fertile soil, only a part of the material grown in the orchard is necessary to maintain such a mulch, and the remainder may be used as feed without injury to the development of the orchard.

Under mulches, roots tend to develop abundantly near the surface of the soil. However, the tree as a whole is no more shallow rooted under mulch than under other methods of soil management, as many roots will also penetrate down into the soil if it is sufficiently open, regardless of the type of surface treatment. Mulching is particularly satisfactory for orchards loca-

ted on steep slopes or in rocky soil where cultivation is difficult or likely to cause erosion. Mulching with high-nitrogen hay may be especially effective in overcoming the serious effects of poor drainage and other unfavorable soil conditions.

Where mulches are used, particular precaution must be taken to control mice. Both field and pine mice are attracted to mulches, and they will eat the bark from the tree trunk and roots. In early fall, the mulch should be removed from immediately about the trunk of the tree back for a distance of at least a foot and a half. If mice are present, systematic poisoning or other control measures also should be practiced.

Hand cultivation immediately around the trees may be used instead of strip cultivation or mulching, under conditions where the orchard is maintained in sod and strip cultivation or mulching is not used. Such a system involves much handwork, as competing vegetation must be kept down for a distance of several feet from the tree, and working at least two or three times each season is desirable.

Fertilization

In most parts of the United States, nitrogenous fertilizers should be added to promote the best growth of the trees. In a few locations, particularly on rather heavily leached soils, potassium may become a limiting factor in the growth of the trees. Under most conditions, however, nitrogen appears to be the only fertilizer material required to give ample growth.

The amount that should be applied will, of course, vary with the age of the tree and with the management practices being followed. It is usually undesirable to add mineral fertilizer before the tree has become established and started growth. One-tenth pound of actual nitrogen, in the form of ammonium nitrate, nitrate of soda, or ammonium sulfate, scattered over an area within 3 feet of the trunk and applied after growth has started in the season of planting, will usually prove beneficial. This amount may be increased as the tree grows older; about one-tenth pound per tree for each year of age of the tree is usually satisfactory. If mulches are used, the quantity of nitrogen can be reduced as the mulch begins to decay. On the other hand, if grass or other sods are growing near the tree, the amount of nitrogen should be increased.

In general, on soils tending to be alkaline, the acid-forming nitrogenous fertilizers, such as sulfate of ammonia, are preferable. On acid soils, the forms of nitrogen that leave an alkaline residue, such as nitrate of soda or calcium nitrate, are to be preferred. Ammonium nitrate is generally the preferred form on soils that are neutral or slightly acid.

The objective in soil-management practices during the early life of the orchard should be to maintain or build up the organic-matter content of the soil, to prevent erosion, and to retain as much available moisture as possible for the growth of the tree. The faster the tree grows during the early years of its life, the earlier it will come into production and the greater the amount of fruit it will produce at a given age. The growing of cultivated intercrops will tend to deplete the organic matter rather than to increase it unless these crops are coupled

with over-winter covers, which are turned into the soil.

Maintenance of the orchard in sod with strip cultivation or mulching around the trees will tend to increase the organic-matter content of the soil and improve the basic fertility. Cultivation of the whole area during early summer, followed by turning a good cover crop into the soil in the spring, should maintain and, in most cases, increase the total organic matter in the soil.

Aside from nitrogen, other essential elements may be deficient for tree fruits in certain areas. Potassium, magnesium, zinc, and boron are among those frequently reported. Since the need for these and other elements varies for different areas, consult your county agricultural agent for specific information.

PRUNING

The purpose of pruning young nonbearing trees is primarily to shape the trees so that the main scaffold branches will be well distributed up, down, and around the trunk. This is the surest way to avoid bad crotches, which may result in breakage later in the life of the tree. Careful selection of the best scaffold limbs early in the life of the tree should make it possible to avoid most large cuts later and thus reduce the hazard of the entrance of wood-rotting fungi into the older trees.

In general, this early shaping of the tree should be accomplished with the smallest possible amount of pruning. Much experimental work has shown that the more severe the pruning of the tree prior to bearing age, the more production is delayed and the smaller the tree will be at any given age. Trees that receive little pruning from the time of setting until they reach bearing age are almost invariably larger and fruit earlier than heavily pruned trees of the same age. Therefore, since pruning tends to be a dwarfing process and to delay bearing, shaping of the tree during its early life should be accomplished with the minimum amount of cutting.

Pruning the tree during the first 4 or 5 years it is in the orchard is more important from the standpoint of determining its structure and strength than any later pruning. From the time the tree is started, it is necessary for the grower to have in mind the general type of tree that will have maximum strength in the framework branches and will support a crop of fruit with least breakage.

At the beginning of the 20th century, the so-called open or vase-type tree was much in favor. In building this type of tree, the main scaffold limbs were taken from near one point on the trunk. The natural central leader of the tree was removed, and several more or less equal limbs were developed. It was thought that this type of tree would expose the maximum fruit surface to light and thus improve the quality.

It was found, however, that such trees were very weak structurally, since the scaffold limbs originating at one point tended to form crotches that split apart when heavy loads of fruit developed; also, heavy

pruning was required to maintain the tree in this form, and the total bearing capacity was reduced. Consequently, in more recent years, apple trees have been pruned almost exclusively to the leader or modified leader type. This gives a stronger tree structurally with greater bearing capacity. Most of the fruit in any case is borne on the outer part, or periphery, of the tree, so that the crop is as well exposed to light with this type of tree as with the vase form. Only the modified leader or the leader tree is discussed in the following paragraphs.

The leader type of tree is one in which a central trunk is maintained. The limbs branching off from this main leader should be smaller at the point of union than the leader branch. Such a union has been found to give the strongest possible type of crotch.

Also, the wider the angle made by the side branch from the central leader, the stronger the resulting crotch. Branches making narrow angles tend to split out, whereas branches from a larger leader, making wide-angle crotches, almost never split. Such branches may break from a heavy load of fruit, but they do not split out from the main trunk.

The ideal tree is also one in which only one side branch develops at the same height on the trunk of the tree. If the main side branches develop along the trunk at points at least 6 inches and preferably 10 to 12 inches apart, the strongest possible tree will develop. In addition to a good distribution along the trunk, main limbs should be as well distributed as possible around the trunk. It is necessary that the pruner visualize how the tree will look, not when it is young but when the main side branches have developed to 3 to 6 inches in diameter. If this point is kept in mind, the necessity for selecting branches well spaced along and around the trunk will be appreciated.

Pruning Young Trees

When the young tree is received from the nursery it may be an unbranched whip 4 to 6 feet high. This is the usual condition if trees 1 year from the bud are planted. Certain varieties, such as York Imperial, may have well-developed side branches even on 1-year trees, and most 2-year trees of all varieties will have a number of side branches when received from the nursery.

One-year whips should be headed at about 30 to 36 inches when planted (fig. 5). If left longer, they are likely to blow in the wind; if headed lower, the branches will grow mainly from near the top of the short trunk that is left and will be close together. A good selection of well-distributed main branches will not be possible after low heading. If side branches have developed in the nursery so that some of them are suitably spaced for scaffold limbs, they should be left on the tree when it is planted and all others should be removed.

The trees can be allowed to grow during the first year in the orchard with no further pruning until the following dormant season. During the winter following one growing season in the orchard, the important selection of scaffold branches must be made.

If the tree has been headed at 30 to 36 inches high and has made good growth, 6 to 12 fairly strong side branches should have developed. Usually those coming from

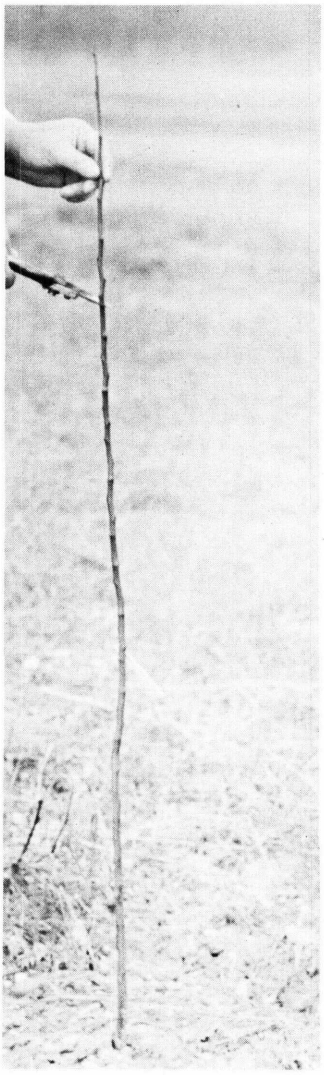

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Figure 5.—A 1-year Stayman Winesap apple tree being pruned immediately after being planted.

the upper part of the tree make the strongest growth. If a good branch has developed from 1½ to 2 feet above the ground, it can be selected as the bottom scaffold limb. One or two additional limbs spaced 6 to 12 inches apart along the trunk and extending in different directions from the trunk should be retained. The upright branch that is retained for the leader should be the strongest growing of all.

It is not necessary, and in most cases not possible, to select all the main scaffold limbs at the end of the first growing season. During the second year, the terminal branch that is left will produce additional strong laterals, which in turn can be used for additional scaffold limbs. Figure 6 shows a strong growing tree of the Delicious variety after 1 year in the orchard, before and after pruning to a modified leader type of tree. Enough well-distributed branches were available to make a good selection of scaffold limbs. Figure 7 shows a tree in which the branches rose too close together on the trunk to make possible the selection of all the scaffold limbs at the end of the first year in the orchard. Additional branches on the leader will have to be selected at the end of the second year in the orchard.

Unless the tree is making exceptional growth, no heading of the branches or leader is necessary or desirable. Shoots making growth of 3 to 4 feet or more may require light heading back to prevent too much blowing and whipping in the wind.

Pruning Trees From 2 Years of Age to Bearing Age

Figures 8 to 11 illustrate pruning treatments for trees 2, 3, and 4 years of age. If a good selection of branches for scaffold limbs has been made during the first 2 years, pruning during later years will consist mainly of removing undesirable sucker growth and of slightly thinning the top. Where two branches may be making sharp and even crotches, this condition should be

corrected either by removing one of the branches or by suppressing its growth through heavier pruning on one branch than on the other. With competing branches as with trees, pruning is a dwarfing process, and the more heavily pruned branch will make less growth the following year than the lightly pruned or unpruned branch.

This principle should be used in correcting bad crotches. If one of the scaffold limbs becomes nearly equal in size to the trunk or leader, it should be suppressed by heavier pruning than is applied to the rest of the tree.

It should be strongly emphasized, however, that pruning during this period should be light and consist primarily of thinning out rather than heading back branches. The heavier the pruning through this period the longer the time that will be required before the trees begin to produce fruit. If the tree has been well shaped during the first 2 years in the orchard, pruning for several years following can be very light and consist essentially in removing any undesirable growth that may come into the young trees.

When the trees come to bearing, the weight of the fruit will tend to spread the tree, and it will be much more open after it has borne a few crops than it will appear to be at 4 or 5 years of age.

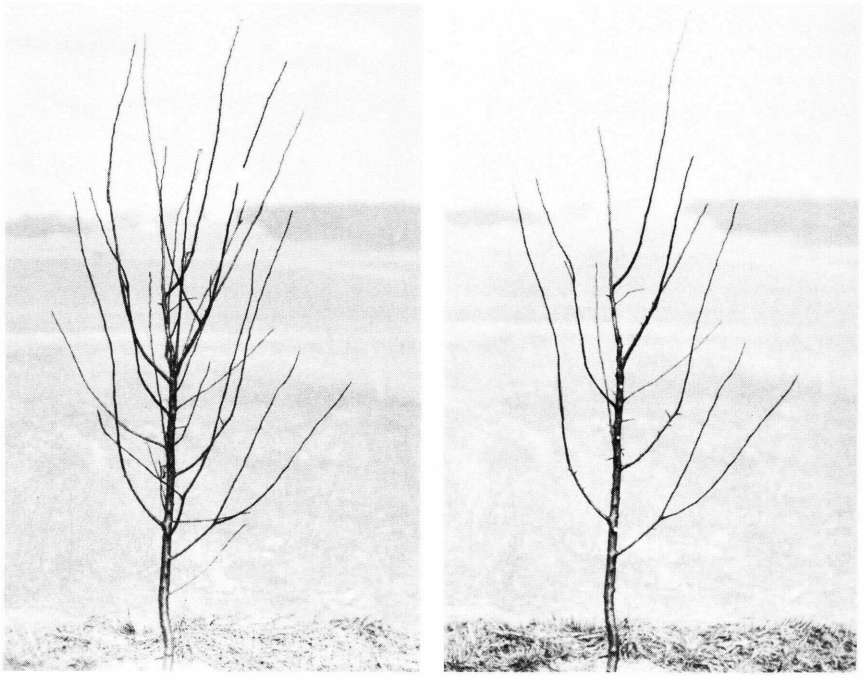

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Figure 6.—A vigorous Delicious apple tree, grown 1 year in the orchard, as it appeared (left) before pruning, showing an ample distribution and number of branches from which to select scaffold limbs, and (right) after pruning. The principal scaffold limbs were all selected at the end of the first year.

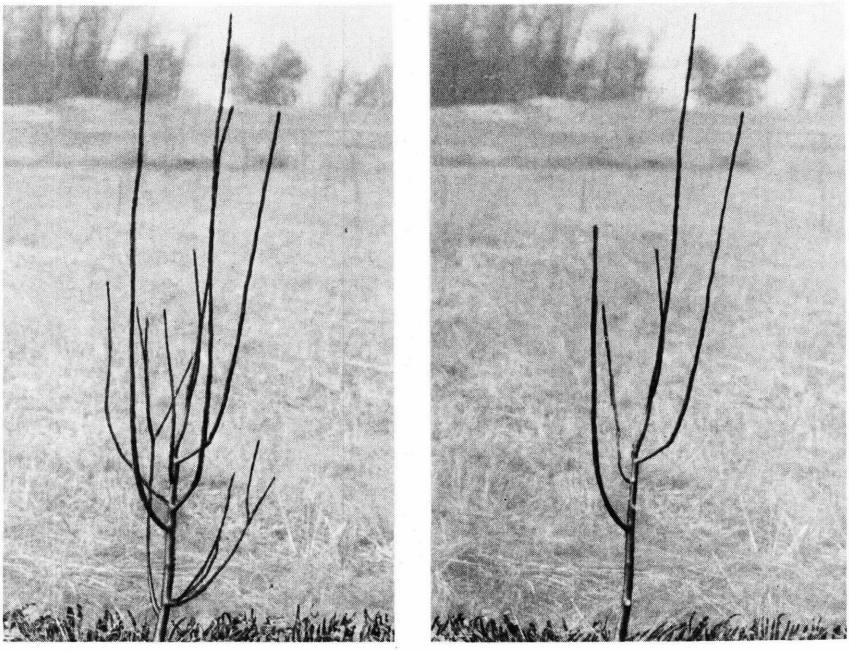

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Figure 7.—Apple tree 1 year old in the orchard (left) before and (right) after pruning. Branches developed too close together to permit full selection of scaffold limbs at the end of the first season in the orchard. Additional scaffold limbs had to be selected at the end of the second growing season.

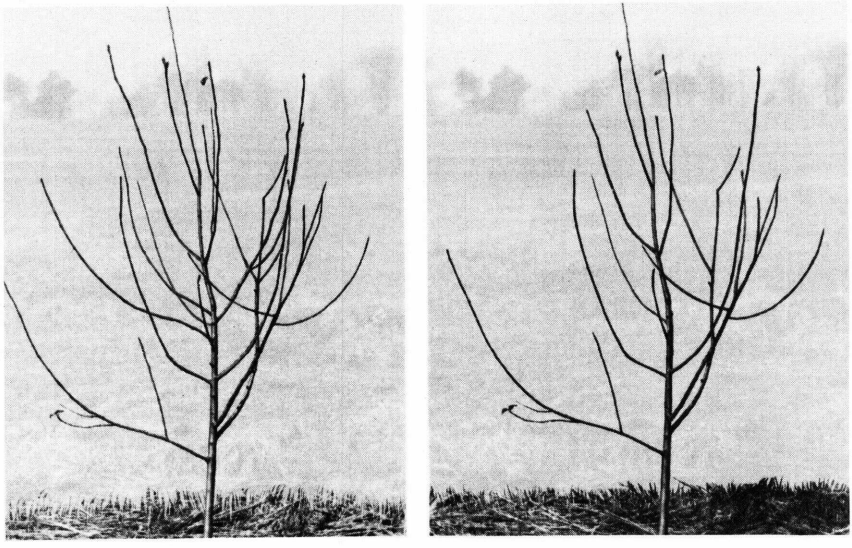

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Figure 8.—A 2-year-old Jonathan apple tree (left) before and (right) after pruning. A good selection of branches was made at the end of the first season. Very little pruning was required at the end of the second year.

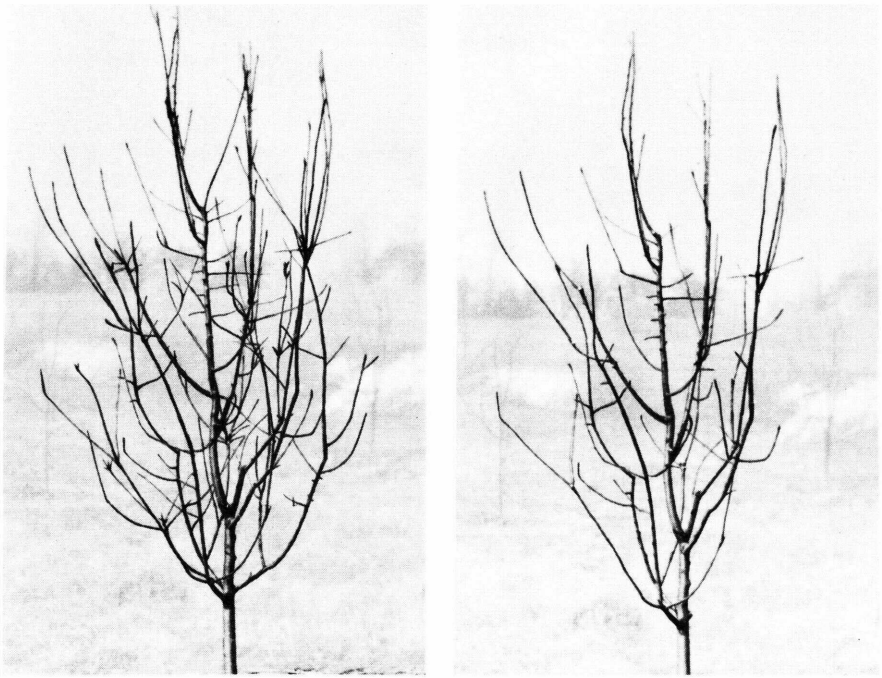

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Figure 9.—A 3-year-old Rome Beauty apple tree (left) before and (right) after pruning.

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Figure 10.—A 4-year-old York Imperial apple tree (left) before and (right) after pruning. Pruning was primarily a thinning out of sucker growth from the trunk and scaffold limbs. A very little thinning in the top of the tree was all that was required.

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Figure 11.—A 4-year-old Golden Delicious apple tree (left) before and (right) after pruning. No major cuts were required, but a light thinning out, primarily of sprouts coming from low down on the trunk or main scaffold limbs. Pruning consisted primarily of cutting out sprouts.

SPRAYING

Much less spraying is necessary on trees prior to bearing age than is required to protect the fruit crop after they are in bearing. It is essential, however, that they be sprayed sufficiently to protect them from insects and diseases that interfere with the growth and development of the tree. In the humid parts of the United States, where apple scab is a serious disease, it is necessary to spray the trees sufficiently to protect the foliage from scab. Unsprayed trees may be defoliated by the scab fungus, in which case growth will be reduced and the trees will be seriously stunted. Two or three spray applications per year should be sufficient to protect such nonbearing trees from serious scab damage. In drier regions, spraying for protection from fungus diseases is usually not required.

In most parts of the country a dormant spray to keep the trees free of scale insects will also be necessary. In many localities it is also necessary to control caterpillars and other leaf-chewing insects. Growers should consult their county agricultural agent for details relative to the spray program.

U.S. GOVERNMENT PRINTING OFFICE: 1967 O—234-438